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EDITORIAL

DISEASE CONTROL

FROM time to time we have commented upon the losses, both financial and from the point of view of national and world food supplies, which accrue from disease in the livestock of countries and the important part which the Veterinary Profession is playing, and has to play, in the control and eradication of disease. Conditions prevailing in different countries determine to a large extent the policy to be adopted in an area, and also how best use can be made of the results of research work on any disease. In this country, for example, diseases which are not considered to be endemic have, up to the present time, been dealt with by a policy of slaughter, together with the control of movement of stock. There is no doubt that this method of control has been highly successful and must be continued wherever possible. The success of the method must depend to a very great extent upon the early recognition of the presence of the disease in the country and the institution of the agreed procedure at the earliest possible moment. Livestock owners are alive to the necessity of early reporting of suspicious symptoms in their animals, and much of the success of the slaughter policy is due to the efforts of such owners in acquainting the authorities with their suspicions.

The introduction of diseases, not endemic in a country, is always possible, and this was never more so in this country than at the present time. While all

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reasonable precautions might be taken by all concerned, the chances of infections being introduced must continue to exist, and the necessary machinery for control must always be readily available. It may happen that, for various reasons, a disease is not recognised until it has been present in a country for some considerable time: its eradication, under such circumstances, becomes a matter of drastic action. If the disease has become widespread it may be necessary to alter the policy of eradication by slaughter, etc., and resort to a method of control, e.g., by vaccination. We, in this country, are proud of our comparative freedom from some of the highly infectious diseases which sweep other countries and continents, and we guard very jealously the slaughter policy which has proved so effective in the past.

Recently, there has appeared in this country a form of fowl pest (Newcastle disease) which presents some difficulty in its recognition by clinical methods. Newcastle disease, in its virulent form, was introduced some few years ago, and although losses were experienced and outbreaks continued to occur it became evident that the disease was well under control and, provided further introduction into the country was prevented, the total eradication of the disease was only a matter of time. The prevalent type of the infection, which appears to be widespread in the country, however, does not lend itself to an easy diagnosis in the field, and the use of laboratory tests has sometimes to be resorted to before a definite opinion can be given on its existence. Further, the tendency is for recovery to take place, sometimes quite rapidly, with the result that poultry-keepers fail to suspect the presence of the condition and its serious implications. At the present time the veterinary authorities are attempting to control this form of the disease by the application of the method adopted for the more virulent disease: time will tell whether this method will yield the desired successful results or whether it will be necessary to give serious consideration to an alteration in policy and recommend a vaccination campaign. Readers will readily realise that such an alteration in policy will not be undertaken lightly, in view of the possibility that it would probably lead to the disease being established in the country for some indefinite period.

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GENERAL ARTICLES

X-RAY DIAGNOSIS OF PREGNANCY IN EWES

By D. BENZIE,

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THE need for early and accurate diagnosis of pregnancy in ewes is important for many investigations which are carried out during the periods of gestation and lactation. At present this is possible only by means of radiography, and it appears from a search of existing literature that up till now diagnosis has been obtained too late in the period of gestation to be of maximum value to the research worker.

The first attempt to diagnose pregnancy in ewes radiologically appears to be that of Curzon and Quinlan (1936), but the published reproductions of these radiographs, even allowing for reduction from the original size, are far from convincing. Wallace (1948) states that with radiograph examinations of pregnant ewes, pregnancy could not be diagnosed accurately before the third month of pregnancy, although examined regularly from the 15th week onwards.

When this work was originally contemplated at the Rowett Research Institute certain preliminary experiments were carried out. The results were sufficiently encouraging to make it worth while proceeding, and suggested that improved technique, with better radiographic results, would allow accurate diagnosis to be made earlier than the third month.

There are two principal difficulties in producing a good radiograph of the fœtus; the first is the effect of scattered radiation, and the second is the effect of respiratory movement of the ewe.

Scattered radiation is produced by the primary X-ray beam passing through the air, the fleece, the tissues of the animal, and those parts of the equipment which it has to traverse. The incidence of scattered radiation must be reduced as far as possible, and precautions to prevent them reaching the film are essential.

The primary X-ray beam, therefore, was confined to narrow limits by means of a localising cone, and the tube distance from the plate was large (3 feet 6 inches), so that softer radiations were lost in the air and did not reach the film. A moving grid (Potter Bucky diaphragm) was also interposed in front of the film during exposure. Clipping both sides of the animal to prevent scatter and absorption by the fleece, as carried out by Curzon and Quinlan (1936), was found to produce only slight improvement of definition. The practice of smoothing the fleece and removing matted wool was equally effective. It was also unnecessary to starve the animals for 24 hours, or to feed the animals on a low roughage diet to reduce the diameter of the rumen. Normal feeding was allowed and the X-ray examinations were carried out between feeding times after having prepared the fleece in the manner indicated above.

Lack of definition due to movement of the animal was reduced by bringing the ewes into the pens outside the X-ray room about one hour before work was commenced. This allowed time for the respiratory rate to subside and reduced excitement. In this way loss of definition due to movement was materially decreased. The exposure was as short as possible, using a powerful four-valve

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unit with a rotating anode tube capable of taking a high load for a fraction of a second.

The dorsal-ventral position (i.e., tube dorsal, plate ventral) was found to give the best fœtal definition, and the ewes were therefore placed across the Bucky diaphragm, and held by two assistants, one holding the forelegs and the other the hind legs. The spine was positioned to the centre of the film and the X-ray tube centred on the fifth lumbar vertebra. (The films were standard Ilford Blue Base and the developer was Ilford Blue Label.)

The exposure technique varied for different ewes, according to size, weight and fleece thickness of each animal; average conditions are given in Table I :—

TABLE I

Exposure Ratings

M.A.	K.V.	Exposure (secs.)	Intensifying screens	Bucky	Tube distance from film
200	75-80	0.2-0.25	Yes	Yes	3 ft. 6 in.

Two breeds of ewes were available and 29 Scottish Blackface and 35 Border Leicester X Cheviots were examined. Radiographs were taken from the 43rd day to the 100th day of gestation, and the results show that pregnancy can be determined with accuracy at approximately the 55th day. More work must be done before an assessment can be made of the accuracy of diagnosis at earlier stages of pregnancy.

The results of the radiological examinations of the 64 ewes are given in Table II :—

TABLE II

Analysis of radiographs

No. of sheep	Days of gestation X-rayed	Diagnosis	Lambs born against diagnosis
1	43	1 x single	1 x twins
1	46	1 x twins	1 x twins
4	50	4 x twins	4 x twins
10	55	4 x singles : 6 x twins	4 x singles : 5 x twins : 1 x triplets
9	60	2 x singles : 7 x twins	2 x singles : 7 x twins
16	65	2 x singles : 14 x twins	2 x singles : 14 x twins
9	70	9 x twins	9 x twins
4	75	2 x twins : 1 single : 1 x triplets	2 x twins : 1 x single : 1 x triplets
6	80	3 x singles : 3 x twins	3 x singles : 3 x twins
1	90	1 x twins	1 x twins
2	100	1 x twins : 1 x single	1 x twins : 1 x single
1	55 : repeat 70	Barren	Barren

Total No. of sheep X-rayed ... 64
Total No. of accurate diagnoses... 62
Total No. of inaccurate diagnoses 2
96.88 per cent correct diagnoses

Photographic prints from radiographs illustrating fœtuses of the 43rd, 46th and 50th day are not very distinct, therefore these have been omitted. Green and Winters (1945) state that bone ossification begins between the 36th and 42nd day of gestation, and it is possible that careful radiography may allow the presence of a fœtus to be detected at this period. Since the pictures are taken in the dorsal-ventral position, the reader's left is also the animal's left.

Fig. 1 demonstrates twin pregnancy at 55 days of gestation. The vertebral column is seen to the left of the 4th, 5th and 6th lumbar vertebræ of the ewe. The second fœtus is seen to the left of the shaft of the ilium.

Fig. 2 shows twin pregnancy at 60 days' gestation. Both fœtuses are seen on the left of the mid line beside the maternal lumbar vertebræ. The head of the one fœtus lies close to the crest of the ilium and is barely visible. The head of the other fœtus can be seen in the intervertebral space of the 3rd and 4th lumbar vertebræ.

Fig. 3 presents twin fœtuses at 65 days' gestation. The fœtus to the left of the mid line lies transversely in the space between the 6th and 7th lumbar vertebræ, while the fœtus to the right of the mid line can be seen immediately oral to the crest of the maternal ilium.

Fig. 4 demonstrates a single fœtus at 70 days' gestation lying to the right of the mid line. The skull can be seen in the 3rd and 4th intervertebral space and the vertebral column runs caudally to the crest of the ilium.

Fig. 5 demonstrates twin fœtuses at 70 days' gestation; the vertebral column of one fœtus is faintly seen transversely in the intervertebral space between the 3rd and 4th lumbar vertebræ, but the bones of the legs are plainly seen beside the 6th and 7th lumbar vertebræ of the ewe. The other is to the right of the mid line caudally to the crest of the ilium.

Fig. 6 presents triplets at 75 days of gestation; one fœtus can be detected to the left of the mid line at an angle to the maternal vertebræ and the lateral edge of the ilium, the second fœtus lies across the crest of the ilium on the right of the mid line, while the third fœtal head is seen at the 4th-5th intervertebral space on the right of the mid line with its vertebral column running in an oral direction with the maternal vertebræ.

Fig. 7 presents twin fœtuses at 90 days' gestation. Their vertebral columns are obvious and both heads are visible. Each head is turned back towards the fœtal tails.

Fig. 8 shows twin pregnancy at 100 days' gestation. The bones of the legs are clearly seen and lie on either side of the maternal vertebræ.

All radiographs taken in the dorsal-ventral position (i.e., X-ray tube dorsal, plate ventral). Reproductions are one-quarter the original size.

The optimum period of gestation for diagnosis is a point that needs further consideration. During the later stages of pregnancy, although there is no difficulty in determining whether or not the ewe is pregnant, it is not so easy to distinguish the number of fœtuses present, for, with the growth of the fœtus, there is a tendency for the individual parts to become confused.

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Summary

Accurate radiological diagnosis of pregnancy in the ewe is possible by the 55th day of gestation using suitable equipment and the technique described.

Radiographs from the 55th day to the 100th day of gestation are presented demonstrating the appearance of the fœtus.

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INTERNATIONAL CONTROL OF DISEASE

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Since the war ended great publicity has been given by organisations concerned in increased food production to the ravages caused by rinderpest and to the adverse influence it exerts on food supplies, particularly in the East. The Food and Agriculture Organisation has made known its desire to see this plague eradicated from the world, and has been working with that end in view. In China up to early 1948 it had a small team which did valuable work. This was interrupted through unsettled conditions arising from the march of Communism through the country. The F.A.O. has also supplied much-needed technical assistance to other countries. Great as this help has been, it is considered insufficient to meet the true requirements of the world in rinderpest control, for the organisation and threatened and infected countries are not strong enough to contain the disease and to prevent it, amœba like, throwing out streams of infection, as recently observed in Afghanistan and the Near East.

Most of the propaganda statements aimed at making the world rinderpest-conscious have been vague. They have, no doubt, brought home to the public the serious nature of the malady; but they are not sufficiently precise on which to build an appeal for a well-financed international attack on the disease. It is necessary to convert vague statements into more concrete evidence.

Thailand (Siam) can offer its quota of evidence on the wide beneficial results arising from a determined and successful effort at total eradication. During the war years and immediately afterwards, a great many rice farms in Thailand were abandoned, largely due to losses of working animals caused by an epizootic of rinderpest covering more than three-quarters of the area of the country, involving directly and indirectly the eight million cattle and buffaloes and some millions of pigs within the infected region. In addition to controlling rinderpest, the veterinary staff had the difficult task, during the height of the epizootic, of transferring working animals from the stock-raising region in the northern uplands, also at that time infected with rinderpest, to the rice growing area in the central plain. By immunisation and quarantine, 142,272 working

PLATE I

FIG. 1
Twin fœtuses of 55 days gestation.

FIG. 3
Twin fœtuses of 65 days gestation.

FIG. 2
Twin fœtuses of 60 days gestation.

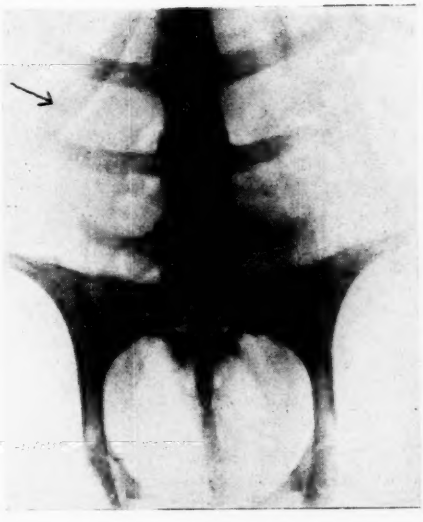

FIG. 4
Single fœtus of 70 days gestation.

(*Article by D. Benzie, page 3*)

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PLATE II

FIG. 5
Twin fœtuses of 70 days gestation.

FIG. 7
Twin fœtuses of 90 days gestation.

FIG. 6
Triplet fœtuses of 75 days gestation.

FIG. 8
Twin fœtuses of 100 days gestation.

(Article by D. Benzie, page 3)

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cattle and buffaloes were delivered to the agriculturalists within three years. Through the use of these animals, it is calculated 1,000,000 acres of farm land were brought back into cultivation, producing paddy to the value of 4,500,000 pounds sterling a year, yielding 160,000 tons of rice for export annually, capable of feeding generously one and a half million people yearly on a mainly rice diet.

For the two years after the war the recorded average annual export of rice was 407,000 tons. In 1949 it had increased to 1.2 millions. This increase could not all have been produced without supression of rinderpest and rehabilitation of farmers in livestock. But the benefits are more far-reaching than that. It is estimated that during the three and a half years of the epizootic the death roll from rinderpest was 300,000 head of cattle and buffaloes and 50,000 pigs. Mortality from that cause has now ceased, and farmers are already finding it difficult to dispose of young stock within the country. This opens the way for a renewal of the export trade in livestock, which will still further augment the world food supply, whilst with the bran milled from the paddy, resulting from the use in agriculture of the 142,272 draft animals, between one and one and a half million pigs can be fed yearly. The reproduction rate of livestock must increase, whilst more attention can now be given to other killing diseases, such as hæmorrhagic septicæmia.

It is a matter for contemplation whether any activity of the various organisations of the United Nations promoted to help nations and the world to sufficiency in foodstuffs, can show such wide beneficial results, in such a short time and at comparative small expenditure, as those arising from eradication of rinderpest.

The benefits mentioned above are an example from one country only. I feel sure other countries can supply similar favourable evidence which in the mass would enable a very strong case to be handed to the F.A.O. for presentation to the United Nations for adequate financial assistance for a global attack on rinderpest with the object of its rapid and complete eradication from all countries.

If we were satisfied with such evidence we would need to consider whether the rate of suppression can be accelerated, and to what degree. We would need to ask ourselves whether we are content with the progress now being made in the eradication of rinderpest throughout the world. If not, we should take the initiative in stating so, and not wait for economists and agriculturists to point out our duty to us. We need to study whether, in spite of more modern biological products, our speed of eradication is all it might be. Is it commensurate with the advances which have been made in the laboratory? In this connection we might compare present-day results with those of the past, such as the cleansing of Europe by strict sanitary measures and the slaughter policy, and South Africa through the recruitment of a large force of inoculators. Several countries at present infected have been fighting rinderpest for twenty, thirty and forty years. In older days in countries now clean there was the will on the part of Governments to sweep the disease away rapidly, which in many instances is lacking to-day. It might not be inappropriate to remark, too, that field campaigns probably received more thought and direction than is applied to-day.

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Rinderpest is a disease which is easy to control if the necessary funds are available for a full-scale campaign and if there are laboratories to provide material for inoculation; but any campaign needs unremitting attention and supervision.

The F.A.O. provides only technical assistance, generally in the development of immunising agents. Admittedly this is very valuable; but there needs to be a balance. It is necessary that there should be an adequate field staff to apply the agents according to a definite plan. Few nations are geared to this, for so often rinderpest eradication is looked upon not as an emergency requiring drastic action, but as a disease to be gradually suppressed over an indefinite number of years.

Figures have been given for this country showing how national income increased due to suppression of rinderpest, and other benefits which developed and are in process of development; but the question might be asked: "Is it worth the extra money required to wage a rapid campaign?" Here again only local experience can be given. This country is now saving livestock from death by rinderpest the value of which in one year translated into money is equal to the cost of the whole of the three and a half years' campaign, whilst through adequate financing of the campaign very much more was accomplished in the three and a half post-war years than during the pre-war attack over a period of eighteen years. It is my definite opinion that had post-war appropriations for the control of rinderpest been on the same scale as the pre-war ones, there would be little hope of this country ever becoming free of the plague. The total cost of a moderate attack calculated over the years with inconclusive result is greater than a short intensive campaign with a successful termination.

If we extend this principle to a global attack the money required would be considerable, but this should neither deter nor intimidate us from stating the amount required. The fight against foot-and-mouth disease in Mexico is being waged on a scale and with a determination such as would be necessary for a rapid world attack on rinderpest. If my memory serves me rightly, when last I read of the Mexican campaign it was stated 1,500 persons were employed and that 35 million U.S. dollars had been spent on it. Any rinderpest scheme submitted should be for world-wide eradication and nothing less, for otherwise the money might be spent wastefully. There might, under a partial scheme, be a resurgence of disease in countries which had been cleansed, particularly in the East.

Provided U.N.O. was favourably impressed with such a scheme, and sympathetic to the granting of funds, the organisation would need to know for how long it would have to face the expenditure. It would be necessary to fix target dates for the various regions. Personally, I am a believer in target dates, for with complete knowledge of local conditions, careful assessment of prophylactic supplies to be expected, and the working capacity of the staff, target dates can be sufficiently accurate. In this country, each phase of the attack was carefully explained to the field staff, who were informed how long it was expected to take. This instilled more enthusiasm amongst the officials and

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produced better working results. On no occasion did they fail to finish the work within the specified time.

A situation which might make the United Nations hesitate to grant funds is the unsettled condition of several countries in the East. It is true there is considerable turmoil. If we analyse it, we find these disturbances arise from three main causes: banditry, nationalistic movements, and Communist activity. There should not be any insurmountable difficulties in eradicating rinderpest in bandit-infected countries. We have had our share of work here. Bandits can be overcome by guile or force, but loss of life must be anticipated—as we have experienced. Bandits may be divided into two categories: first, small roving bands who are not owners nor in the control of livestock except through the fear they instil in the farmers. Within their sphere of influence veterinary work can be carried out, though there is always danger of an incident. The second and more important group is that of bandits with well-established strongholds in control of large areas. Such areas could be cleared by force, or the area could be sealed off and the disease left to burn itself out.

In areas in which there is political unrest there seems good hope that a lot could be accomplished. Both sides have declared and undeclared allies, and though one side might chase with a gun a member of one nationality, that of another who came to help would be welcomed. But political unrest is subsiding now in South-East Asia. The two troublesome areas now are Viet-Nam in Indo-China, and parts of Burma.

With militant Communism, the main danger to those countries not given over to that creed might be wilful dissemination of disease to clean countries, which, with reasonable preparation against the danger, could be dealt with in the routine way. Where, however, a Communist country adjoins a democratic one, both of which are infected, it is possible to come to some arrangement for mutual help. Such a situation exists in Korea.* The North is Communist and the South democratic, yet when the Communist veterinary staff applies to that of the democratic area for immunising agents against rinderpest, they are willingly given.

And so in China, where working animals are so important to the economy of the country; if there are insufficient prophylactic products and insufficient staff, I cannot credit that any offer to help would be refused. I consider, therefore, considerable assurance could be given to the United Nations that funds granted would not be wasted.

To develop global strategy, regional plans would need to be drawn up and co-ordinated into one master plan. Africa might comprise one region; the Middle East, India with Pakistan, South-East Asia, China, etc., others. In Africa, experience shows that success in eradication can be achieved through mass immunisation with goat virus. To fix a target date when all animals in the necessary regions there can be immunised would seem to be partly an arithmetical problem. If, for instance, with the existing staff suppression is calculated to take five years, how long would it take if 1,000 extra men were

* This article was written before the invasion of S. Korea in July, 1950.

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employed as inoculators, and how many would need to be retained to deal with the menace of reinfection from wild game until the disease in wild game disappeared? It would appear, if "Antrycide" proves as valuable as reports indicate, that Africa may have a very big task ahead in making large areas suitable for the rearing of livestock. With the rapid disappearance of rinderpest, such a valuable progressive work could be expedited.

Can India, through Pakistan to the Himalayan passes, be cleared step by step through the recruitment of another 1,000 inoculators and whatever agents may be necessary? Similarly, is it possible to cleanse South Asia from the sea to the China border; and then, as a first step, China to the Yangtze? I believe, if schemes along these lines were drawn up and co-ordinated, real and rapid progress would be made.

It would also be the duty of the veterinary service—operating with the first desire to free the world from rinderpest—to include arrangements for the rehabilitation of farmers in working animals, for the basic idea of eradication is to produce more food for the world. If farmers whose stock has been ravaged by rinderpest have to await natural increase from depleted herds to put the land back into cultivation, the increase in food will be slow. But if a veterinary service, operating under U.N.O., could survey the ground, ascertain where there is a surplus of suitable stock, earmark the required number for purchase, immunise them in readiness, and work out in advance the most practical method of delivery, the necessary livestock could be supplied with the minimum of delay and cultivation could proceed rapidly.

To-day the Philippines Veterinary Service is scouring the East for working animals through lack of which agricultural activity is reduced. When Burma settles down again, probably the main requirement will be working animals, for it is the largest rice-growing area in the world. There is probably a shortage of working animals in Indo-China, the second greatest rice-producing country. It would be a tragedy if cultivation is delayed in those countries for lack of forethought and organisation in advance.

Mention has been made as to how the Siamese, or to give them their present name, Thai veterinary staff contributed in these post-war years towards alleviation of starvation amongst the rice-eating peoples of the world. In considering plans to deal with the large epizootic of rinderpest, it was decided to adopt one with the object of freeing the whole country in a systematic manner. The Government accepted the plan and provided the money required. It was estimated the plan would take five years to fulfil: actually it took three years and seven months. When a survey was made of our sinews of war they were found to be pitiably small. The staff was numerically weak. Fifty persons a year were recruited and given six months' tuition. There were just a few litres of serum, so a large supply was ordered and flown in from India. Goat virus proved to be contaminated with wild virus, so seed virus was obtained from Rangoon. Difficulties arose in obtaining buffaloes for preparing inactivated vaccine through lack of trucks and destruction of bridges and the permanent track. Those obtainable had to be driven about 200 miles by road, and herds

were frequently infected with rinderpest on arrival at the laboratory. It is safe to say that had the supply position been adequate from the commencement the epizootic could have been suppressed in two years.

The scheme was put in operation in late May, 1946, and carried to a successful conclusion by December 23, 1949, since which time the country has been free. The epizootic covered the central plain, the north, and north-east. The south was free. Excepting the south, only three out of 57 provinces comprising the rest of the country were free of infection. Eight million cattle and buffaloes and several million pigs were involved. The number of veterinarians was far too few to attempt to attack rinderpest wherever it existed, nor were there prophylactic agents sufficient for such a measure. To obviate dissipation of manpower and material it was decided to restrict work to an area where it could be done thoroughly. Veterinarians were drawn from all provinces — that is, provinces outside the area of operations were abandoned to their fate. The veterinarians were transferred to the most southern edge of the infected area adjoining the clean area in the south, where the peninsula starts. Here they were assembled into two forces, an advance force called the "eradication force," and a reserve one called the "searching force." The campaign was divided into three phases: firstly eradication in the centre, then the north, and finally the north-east.

The eradication force was instructed to advance on definite objectives towards the north and north-east, eliminating outbreaks wherever encountered. It moved forward as a co-ordinated line across the country, the general movement being controlled from headquarters and adjusted to the progression and retrogression of the disease. The searching force had the duty, after a suitable interval, of following in the footsteps of the eradication force to make certain that outbreaks dealt with by that force had actually been suppressed, and to inspect every animal in every village and in jungle feeding-grounds for concealed and unreported disease. It might be mentioned here that, in spite of legislation demanding early notification of disease, it was known that farmers could not be relied upon to report early; so the most satisfactory method, and the only one of establishing confidence that an area was clean and that all threats of reinfection in the rear were removed, was for the veterinary staff to search the whole area thoroughly. If dependence had been placed on farmers to report outbreaks, results would have been disappointing, for so often movement of infected livestock was in advance of reporting, favouring conditions for rinderpest to become enzootic.

By the above means the central area, containing two million cattle and buffaloes, was cleaned up in two years; whilst in the second year progress towards the north was so satisfactory that the left wing of the forces had reached their objective long before the target date. Instructions were then given for it to advance to the second objective in the north, which was the border of the Shan States of Burma. This, too, was reached by the end of the second year. The northern area also held two million cattle and buffaloes, so the attack by

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the end of the second year had cleansed territory holding four million cattle and buffaloes and some millions of pigs.

When the right wing had achieved its purpose and reached the slightly mountainous country encircling the north-east territory, a halt was called for transfer of a large part of the staff from the north, general reorganisation and accumulation of supplies before launching the last phase in the north-east, considered to be the toughest of all. Here the snowballing effect of the scheme—whereby the staff, through the continuously contracting area to be dealt with, was becoming progressively stronger—was most evident. Hitherto there had been frontal attacks. In this region it was considered a wide encircling movement directed towards a centrally situated province would be more effective. Within this large circle a small encircling movement was developed in an area particularly heavily infected, with much wild game dying of rinderpest. This programme in the north-east, containing four million head of cattle and buffaloes and an unknown number of pigs, started on July 1, 1948, and was completed by December 23, 1949. Here the same policy of having a reserve to follow the eradication force was adopted. Following the disappearance of the disease, 283 veterinarians searched the whole of the area a second time.

During the period of the post-war campaign, covering roughly three and a half years, 1,593 outbreaks were dealt with, requiring the use of:—

Serum anti-rinderpest	22,400 litres
Inactivated vaccine (buffalo spleen)	750,000 doses
Goat virus	485,000 doses
Lapinised virus	100,000 doses

Except for most of the serum, which was obtained from India, the other agents were produced locally. Lapinised virus was introduced from China by Mr. H. S. Purchase when he was here on the F.A.O. Mission and through the courtesy of that organisation. It was used mainly on buffaloes and was greatly appreciated by farmers, so much so that they searched the country for rabbits, which they produced asking that the vaccine to be used be made from them. There were not sufficient rabbits to enable it to be used on a larger scale.

The success of the above-described campaign was achieved because the Government provided adequate funds; they also backed a policy which was very drastic—that is, to abandon for a time a great part of the country to the ravages of the disease in order that by progressive eradication from one area to another the disease might finally be eradicated from the whole kingdom.

The problem now that the country is free is prevention of reinfection from adjoining countries. This should not be a problem for this country only—the main onus should be on the infected countries. At the July Rinderpest Conference here we were recommended to set up immune belts, but although accepted it did not conform to our idea of progress. Immune belts may be good in theory but are quite impractical for the East unless there is a product which can give to buffaloes and pigs a reasonable duration of immunity, which there is not for both species. Further, any animals entering the country would be introduced surreptitiously along jungle paths. A sizeable infected

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herd could travel 250 miles before being brought to a halt through widespread sickness. Due to the configuration of the country and the situation of infected countries, it would mean—even if we had suitable immunising agents for all species—that we would, for an indefinite time, have to keep under permanent immunisation about six million cattle and buffaloes and several million pigs to feel reasonably safe. This seems such a waste when with the same effort large areas in neighbouring countries could be reclaimed from rinderpest.

If there is co-operation between adjoining nations and a co-ordination of programmes, so that eradication is progressive from one area in a country to its borders, and then from that country to the next one towards some massive objective easily defended pending the next internationally-arranged phase being carried out, the necessity for prolonged defensive measures in the various countries would not arise.

At the Bangkok conference the Thai delegation proposed an international regional research station for South East Asia. The idea was not approved. This was a very grave mistake, for the more one considers it, the more essential does this seem necessary; for there has been no agent produced to confer upon two-thirds of the livestock in this region (buffaloes and pigs) a long-term immunity against rinderpest.

A cheap and effective prophylactic giving long-term immunity to buffaloes and pigs would help towards speedy control of rinderpest, and research towards that objective is of outstanding importance for South Asia and China.

Although Thailand is free of rinderpest, the Government is still devoting considerably more money to research in that disease than any other country in the "rice bowl."

If there is to be a global attack on rinderpest it must be under central direction. At the July Rinderpest Conference (Bangkok) I suggested an effort should be made to obtain an International Veterinary Service. This received no support, but I was heartened to read that at the International Conference held in London shortly afterwards Lord Boyd Orr advocated something similar. So far as I am aware, nothing has been done towards translating that advice into reality.

We have at present two bodies concerned with the international aspect of disease—the Office International des Epizooties (Paris) and the F.A.O. The prime function of the "Office" in pre-war days was to issue information concerning disease. Such information is now more necessary than ever. The F.A.O. helps towards providing the sinews of war against disease by sending technical experts to those countries which require assistance in the development of prophylactic agents.

It is advisable for there to be an amalgamation of the "Office" and the veterinary division of the F.A.O.—whether as a separate organisation or as a division of the F.A.O. better brains than mine could decide—to enable a self-governing International Veterinary Service to be formed. There is one weakness I see in the F.A.O. from a veterinary standpoint. It is unable to give assistance to nations which are not members of that organisation. This would place the

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veterinary division in a difficult position when its purpose may be to eradicate a specific disease from the world; it could go so far but when, for the final assault which might mean success, it is brought up against a nation which is not a member, the campaign must halt. There might then be a backwash of disease which would defeat the whole plan.

My proposal for an International Verterinary Service is founded largely upon the necessity for the suppression of rinderpest everywhere. But if nations are asked to give financial support to a scheme of this nature, one can understand that those remote from the danger may not be enthusiastic; but there are other diseases of economic importance, and although rinderpest should receive priority, yet the groundwork can simultaneously be laid for attacking other diseases in the various countries on an adequate scale. To take but one example, contagious pleuro-pneumonia of cattle has been enzootic in the northern territory of Australia for a very long time. Is it possible to eradicate and, if so, what men and funds would be required to eliminate it quickly? It is mass attacks such as these which I believe are required in the world to-day, and only an international Service can provide for them.

It would be incomplete for me to advocate such a measure as this without trying to put forward some constructive ideas as to how the Service might be organised.

INTERNATIONAL VETERINARY SERVICE

Rinderpest Branch

I

A temporary Committee shall be set up to study the effect of rinderpest on national and world economy. Each infected country to be invited to submit a report. The temporary Committee to present a report, based on a study of these reports, to the F.A.O. for transmission to the U.N.O.

II

Should the report be accepted by the U.N.O., the temporary Committee shall elect a Central Veterinary Council and then resign.

III

The Central Veterinary Council shall comprise:—

(1) The Senior Veterinary Official of the F.A.O.;

(2) The Chairman of the "Office"; and

(3) Liaison officials from Regional Councils.

IV

The Central Veterinary Council shall request each region to set up a Regional Veterinary Council, to meet not less frequently than once a month, composed of:—

(1) Representatives from each infected country; and

(2) Representatives from each country adjoining an infected country.

V

The duties of a Regional Council shall be:—

(1) To draw up a budget and allocate money received from the Central Council;

(2) To call upon each infected country to submit a plan for eradication;
(3) To determine what additional help a country needs;
(4) To organise supplies of prophylactic agents;
(5) To enrol volunteers to meet an emergency anywhere at three days' notice; and
(6) To amalgamate national schemes into regional plans.

VI

The duties of the Central Council shall be:—
(1) To prepare an annual budget for presentation to the F.A.O. (or the U.N.O.) and allocate funds to Regional Councils;
(2) To inquire of infected countries to what extent budgets can be stepped up;
(3) To weld regional schemes into world-wide strategy;
(4) To develop regional research laboratories;
(5) To stockpile prophylactics to meet any emergency anwhere, so far as is practicable; and
(6) To provide funds for the "Office" unless incorporated in the Service.

VII

Regional Councils shall be empowered, where countries are disturbed, to enter into negotiations with both parties, when it is considered that by so doing eradication would be facilitated.

VIII

The Service to be strictly neutral and international. In disturbed areas it shall operate under a symbol of neutrality (e.g., a blue-cross flag).

IX

Any nation, whether a member of U.N.O. or not, contributing or not, shall be eligible for help when it comes within the scope of the eradication programme.

X

The Service shall have at its command, for service anywhere, a substantial mobile force created of:—
(1) Veterinarians and inoculators, officials of the Service;
(2) Volunteers enrolled by Regional Councils; and
(3) Locally-recruited personnel.

* * *

It must be understood that the above is entirely my own private and personal opinion and no official significance must be attached to it.

I believe if a careful investigation of the harmful effects of rinderpest is made, and if the information gained is ably presented, it would provide an impressive document. I trust those in a position to do so will undertake the work and will press for the advice of Lord Boyd Orr to be adopted, so that we, like our medical confrères, may be able to deal with disease on a co-ordinated and co-operative world-wide scale.

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MARROW BIOPSY IN SHEEP

1. Normal

By C. S. GRUNSELL, M.R.C.V.S.

In the human, bone marrow biopsy is now a commonly adopted procedure in the diagnosis and study of functional pathology of blood diseases. Custer[5] and many others have stressed the importance of understanding the role of the bone marrow when interpreting the blood picture in health and disease, and Jones[10] has shown this is best achieved by bioptic sampling of marrow, a series of samples being taken when necessary. Many of the more chronic diseases encountered in veterinary medicine, have demonstrable changes in the peripheral blood picture, and it may well be that a more general study of the marrow changes throughout the course of the disease will lead to a better understanding of the relationship of the blood changes to the disease as a whole. Furthermore, the increase in the use of animals in the study of human blood diseases suggests the need for a standard technique in marrow biopsy to permit a more ready correlation of the results of workers in the medical and veterinary fields.

The various methods employed in human medicine are discussed by Wintrobe[16] and by Osgood and Seaman[13]. The commonest method in use is that known as Sternal Puncture. With this technique, marrow has also been obtained during life from some of the domestic animals[7, 8, 11], although some workers have chosen the rib[4, 12], or the iliac crest[1, 2], as the site in preference to the sternum. In a search of the literature, however, no reference to bone marrow biopsy in the sheep could be found apart from an allusion to the iliac crest as a possible source[1].

It was, therefore, decided to test sternal puncture as a method of obtaining marrow from the living sheep, and if the material so obtained was suitable, to study the constituent cells and their incidence in the marrow.

The technique was found both simple and effective and from preparations of the aspirated marrow, it was possible to examine cell morphology and construct myelograms.

This report contains a description of the technique evolved, and an indication of some of the information that can be derived from the marrow preparations obtained by this technique.

Material and Methods

The material consisted of ten Cheviot ewes between the ages of three and six years old which were pregnant and all came from the same Scottish hill farm. No anthelmintic treatment had been given for six months prior to sampling. The sheep were slaughtered twelve hours after the marrow biopsy was performed and the only pathological findings were those attributable to the light nematode infestation revealed by an examination of the alimentary contents. At the time of marrow sampling, blood was collected from the jugular vein and subjected to total and differential cell counts and hœmoglobin estimation. The values obtained were all within the range covered by twice the Standard

Deviation added to, or subtracted from, the mean using the standards fixed by Holman[3]. The work was done between December 14, 1949, and March 8, 1950.

The equipment for bioptic sampling of marrow from the sternum was as follows:—

1. Two per cent procaine solution.
2. Two ml. syringe needles—bore 1 mm., length 4 cm.
3. One ml. syringe.
4. Salah needles—bore 1.5 mm., length 4 cm.
5. 3.8 per cent sodium citrate solution.
6. Watch glasses.
7. Fine pointed forceps.
8. Slides—clean and grease-free.

Technique of Sternal Puncture

The sternum of the sheep is a median segmental bone consisting of seven sternebræ united to each other by cartilage. The anterior extremity of manubrium is formed by the first sternebra which is elongated and narrow with a free tuberous extremity. It is curved upwards and is palpable. The posterior extremity or xiphisternum is formed by the last sternebra; it is elongated, narrow and flattened and has a well-defined xiphoid cartilage and may also be palpated. The body is composed of the five remaining sternebræ which are distinctly flattened and increase in width towards the posterior extremity. The ventral surface of the body is superficial and between the first and second sternebræ there is usually a well-defined prominence. The lateral surfaces of the body are narrow and bear at the junction of adjacent sternebræ, concave facets for articulation with the cartilages of the sternal ribs.

The results given in this report are from the examination of marrow from the third sternebra, but it was found that puncture of the second and fourth sternebræ was equally satisfactory.

The sheep was restrained in a sitting position by an assistant who stood behind the sheep to support it and held a foreleg in each hand. The third sternebra was located by following the third rib down to its articulation with the sternum. The wool was clipped from the part and the skin cleansed with spirit. The skin, subcutaneous tissue, and periosteum of the third sternebra was then infiltrated with 1-1.5 ml. procaine 2 per cent.

The Salah needle and syringe to be used for aspiration were sterile and dry. Immediately before the puncture was made both syringe and needle were washed out with 3.8 per cent sod. citrate solution to prevent clotting occurring in syringe or needle during the operation. (Davidson *et al.*[6])

With the stilet *in situ* and the needle held at right angles to the body of the sternum, a puncture was made as near the centre of the third sternebra as possible. The needle was pushed through skin and subcutaneous tissue until it could be felt and heard against the bone. Penetration of the bone to a depth of approximately 0.5 cm. was achieved by a screwing movement, and in most cases a sudden reduction in resistance could be felt as the marrow cavity was

entered. The depth of penetration measured from the skin varied from 2.5 - 3.8 cm. The stilet was withdrawn and the syringe attached to the needle. Gentle suction was applied until approximately 0.3 ml. of marrow fluid had been withdrawn. The syringe was next detached and the contents expelled on to a watch-glass; when the blood was poured off the marrow flecks could be seen remaining adherent to the watch-glass. The flecks varied from 20 or 30 to several hundreds in number, and measured from 0.5 to 4 mm. in size.

Marrow spreads were prepared at once according to the technique described by Davidson *et al*[6]. This consisted in transferring four or five flecks by means of fine pointed forceps to one end of a slide. These flecks were then crushed and spread by means of another slide held at right angles to the first. In order to damage the cells as little as possible, it was found very important to exert only enough pressure to make a good spread of the tissue. Considerable practice was required before satisfactory preparations could be made. At least six spreads were made from each aspirate.

No after-treatment was necessary apart from the removal by means of a swab of a small amount of blood which exuded from the hole following the withdrawal of the needle.

Staining

The spreads were air-dried and defatted in chloroform for 30 seconds, and staining was then as follows:—

1. Undiluted Leishman (Revector)	2 minutes
2. Dilute Leishman—1 part Leishman to 2 parts distilled water	6 minutes
3. Dilute Leishman removed by tilting slide—no washing	
4. Dilute Giemsa (freshly prepared)—1 part Giemsa to 9 parts distilled water	8 minutes
5. Washed and differentiated with distilled water	2 minutes

Cell Identification and Nomenclature

Before undertaking this examination of sheep's marrow, a study was made of human marrow cells in spreads prepared by the above technique. The classification and nomenclature used was that proposed by Israels[9] with one modification, namely a subdivision of the neutrophil metamyelocytes into 'juvenile' cells and 'stab' cells (Schilling[15]).

Differential Cell Counting

A survey of the cell distribution on the slide, made under the low power, gave a general indication of areas likely to be suitable for study; however the selection of fields for differential counting was carried out under the 1/12 oil immersion objective. The only factors considered in the selection of these fields were that the cells should be recognisable and that the fields should be as near the centre of the squashed fleck as possible. The object of the latter precaution was to reduce the error due to the alteration in the relative distribution of the cells by the act of spreading, the supposition being that this would be less towards the centre of the spread.

In the case of each sheep approximately 340 cells on 3 slides were differentiated making a total count of over 1,000 cells.

Cell Measurement

Hæmocytoblasts, proerythroblasts and all cells younger than metamyelocytes in the myeloid series, were measured by micrometer eyepiece. In the case of the remainder the images were projected in a dark room by a prism on to a sheet of paper and measured by a ruled scale. This latter procedure was adopted in the case of the more easily recognisable cells for its greater accuracy and because it caused less eye strain than measuring by micrometer eyepiece.

Results

In general morphology, structure of nuclear chromatin, and staining of nucleus and cytoplasm, it was found that the marrow cells of the sheep agreed closely with descriptions of their counterparts in the human. However, a marked difference between the two species was seen in the staining affinity of the granules in the myelocytes and metamyelocytes of the neutrophil granulocytes. In the sheep the granules were seen to be almost colourless against the very pale blue background of the cytoplasm. It was also found that although the 'reddish' granules were well marked in the eosinophil series, they were smaller and much less numerous, in the neutrophil granulocytes, than was the case in the human.

The cellular composition expressed as a percentage is given for each sheep in Table I, which contains also the myeloid/erythroid ratio and the percentage of cells seen to be in mitosis. The details for each sheep include age, stage of pregnancy, total worm burden, hæmoglobin level, and peripheral blood cell counts, all as at the time of sampling. A detailed account of the worm burden of each sheep is shown in Table II.

Table III shows the mean values for the differential counts on the 10 marrow samples, with the ranges of incidence of each cell. The table also shows the mean size and range of size for each cell, with the number of cells measured.

Discussion

Consideration was given to the question of quantitative estimations of the cellular content of the aspirate, but in view of the inaccuracies in the technique disclosed by the work of Reich and Kolb[14], no attempt was made to do this. Moreover, as the quantitative examination would be carried out on the marrow blood, while the qualitative estimation was made on actual marrow particles, the application of one value to the other would be illogical.

No results of sternal marrow biopsies in sheep were available for comparison with the present findings, but the higher proportion of erythroid elements found in the marrow of these sheep compared to man agreed with the results given by Holzel[8] and Hjarre[7] for cattle. The low incidence of lymphocytes and monocytes recorded here for sheep's marrow compared with figures for cattle may be explained by the relatively lower dilution with blood which occurs when the preparation examined consists of crushed marrow flecks rather than a smear of

marrow blood. The high percentage of eosinophil granulocytes found in these marrows compared with the figures obtaining for man may be accounted for by the persistent, if at times not very heavy, parasitism to which sheep are exposed.

Summary

(1) A method of marrow biopsy by sternal puncture is described for sheep.

(2) The preparation and staining of marrow spreads is detailed.

(3) Myelograms constructed from differential cell counts on marrow spreads from 10 Cheviot ewes are given.

The work reported is a section of a wider research subject upon which the writer is at present engaged under the direction of Professor D. Murray-Lyon and Professor Geo. F. Boddie.

Acknowledgments

The animals used in this work were sampled before they were killed as part of an investigation into the helminth burden in Scottish hill sheep carried out under the auspices of the Agricultural Research Council. I am most grateful to Dr. D. O. Morgan and Dr. I. Parnell, in the first place, for being given access to the material, and also for permission to use the worm burden figures in this report.

I also wish to express my grateful thanks to Mr. R. C. W. S. Hood for the photograph shown as Fig. 1.

The photography for Figs. 2 - 8 was carried out by Mr. J. C. Rennie to whom I am greatly indebted for technical assistance and advice in the preparation of the illustrations to the report.

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FIG. 1.—Longitudinal section of sheep's sternum with Salah needle in position for marrow aspiration. The movable guard shown here was used in the earlier stages of the development of the technique to restrict sternal penetration to approximately 0.5 cm.

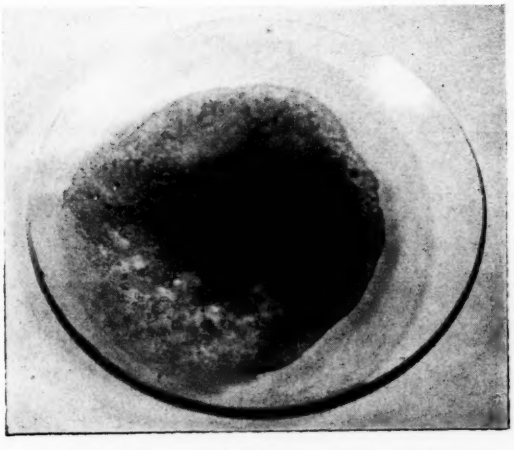

FIG. 2.—Watch glass showing marrow flecks adhering to the glass after the removal of marrow blood.

(*Article by C. S. Grunsell, page* 16)

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PLATE II

FIG. 3.—Preparation of the marrow spread. The fleck is shown in the process of being crushed. The spread will be made by moving the upper slide to the left, thus spreading the crushed fleck.

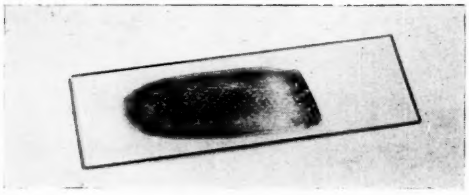

FIG. 4.—Stained marrow spread, showing crushed fleck in the centre surrounded by marrow blood.

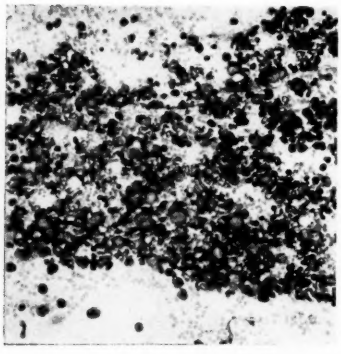

FIG. 5.—Area of the spread suitable for differential count. x 200.

FIG. 6.—Marrow cells. x 1,000.

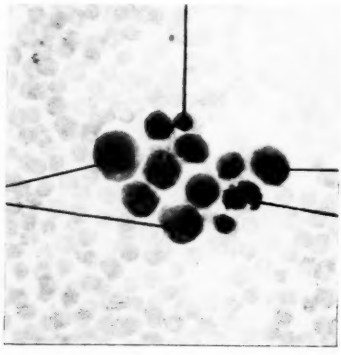

FIG. 7.—Marrow cells. x 1,000.

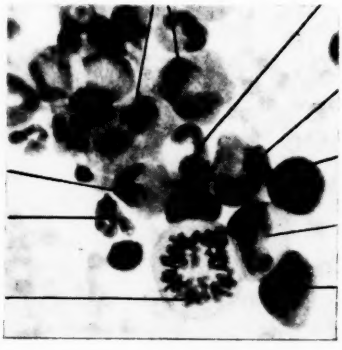

FIG. 8.—Marrow cells. x 1,000.

(*Article by C. S. Grunsell, page* 16)

TABLE I

Differential Marrow cell counts and Myeloid-Erythroid Ratio of 10 normal Cheviot Ewes (1,000 cells counted). Showing also in respect of each sheep, age, stage of pregnancy, total worm burden, and results of peripheral blood examination. (P=Present.)

Number of sheep	68	54	56	63	67	51	57	58	52	65
Year of birth	1944	1944	1946	1947	1945	1946	1945	1947	1944	1944
Stage of pregnancy, in days	32	60	60	74	74	38	102	102	88	116
Worm burden. (For details see Table III)	2	334	1,082	465	141	164	400	1,305	60	662
Marrow Cells as a %										
Haemocytoblasts	0.1	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Myeloblasts	0.3	0.2	0.0	1.1	0.4	0.5	0.1	0.7	1.4	1.0
Promyelocytes	0.6	0.3	0.2	0.6	0.1	0.3	0.1	0.0	0.0	0.2
Neutrophilic Myelocytes	2.7	4.0	5.9	4.9	3.2	5.7	4.3	5.7	1.5	8.1
" M/myelocytes	3.5	2.9	4.2	5.1	2.1	5.5	6.0	4.5	5.4	4.9
" Stab cells	20.1	13.9	21.8	16.2	14.3	14.0	22.5	16.8	12.6	10.6
" Polymorphonuclears	5.6	2.4	6.7	2.3	1.4	5.4	6.2	6.9	3.6	5.3
Eosinophilic Myelocytes	3.3	5.6	4.6	4.2	3.7	4.8	6.2	5.5	5.4	5.2
" M/myelocytes	13.5	8.6	8.5	15.0	14.5	12.2	8.6	11.5	8.2	7.8
" Polymorphonuclears	3.2	3.9	2.6	0.8	3.0	1.8	3.8	3.0	5.1	0.8
Basophilic Leucocytes	1.1	0.6	2.3	1.0	0.3	1.1	1.1	0.8	1.2	1.0
Proerythroblasts	0.9	0.8	0.5	1.1	1.1	1.1	0.9	0.9	0.9	1.4
Early Normoblasts	4.9	1.5	2.5	2.7	2.9	3.4	3.4	3.2	3.6	4.9
Intermediate Normoblasts	29.6	37.3	29.5	27.2	37.1	30.0	27.9	31.9	33.6	34.5
Late Normoblasts	6.8	15.0	7.1	15.1	12.4	8.7	4.9	5.8	14.2	9.1
Plasma Cells	0.0	0.3	0.3	0.3	0.4	0.7	1.0	0.0	0.3	0.2
Reticulum Cells	1.2	1.4	0.9	0.8	1.1	1.6	1.7	2.0	1.3	1.9
Lymphocytes	2.3	1.5	2.2	1.2	1.2	2.6	1.1	0.6	1.5	3.1
Monocytes	0.3	0.1	0.2	0.2	0.7	0.5	0.2	0.2	0.2	0.0
Megakaryocytes	P	P	P	P	P	P	P	P	P	P
Myeloid/Erythroid Ratio	1.28 : 1	0.77 : 1	1.43 : 1	1.11 : 1	0.81 : 1	0.81 : 1	1.68 : 1	1.32 : 1	0.85 : 1	0.97 : 1
Mitotic Forms	0.7	0.2	0.5	1.6	—	1.4	0.9	0.8	0.8	0.7
Peripheral Blood										
Erythrocytes, millions per c.mm. ...	9.2	11.3	11.2	10.2	11.2	10.7	8.4	10.3	12.1	8.9
Haemoglobin, gms. per 100 ml. ...	10.1	10.5	10.2	10.2	10.8	10.9	9.7	10.8	11.6	9.1
Leucocytes, thousands per c.mm. ...	8.0	5.3	7.4	7.4	7.0	5.3	8.8	10.4	8.4	10.6

TABLE II

Differential marrow cell count—means and ranges for 10 sheep of which details are given in Table I. Mean size and range of size for marrow cells and number of cells measured.

Cell	Differential Marrow Cell Count. %		Cell Sizes μ		No. of cells measured
	Mean	Range	Mean	Range	
Hæmocytoblasts	0.005	0.0 - 0.2	33.0	—	1
Myeloblasts	0.47	0.1 - 1.4	19.18	18.3 - 22.0	45
Promyelocytes	0.24	0.0 - 0.6	19.60	16.6 - 28.2	18
Neutrophil myelocytes ...	4.60	1.5 - 8.1	20.30	12.0 - 30.0	174
„ M/myelocytes	4.33	2.1 - 6.0	*14.63	10.0 - 23.0	204
„ 'Stab' cells ...	16.38	10.6 - 22.8	Included in above figures		
„ polymorpho-nuclears	4.58	1.4 - 6.9	Not measured		
Eosinophil myelocytes ...	4.85	3.3 - 6.2	20.57	11.0 - 40.0	207
„ M/myelocytes	10.84	7.8 - 15.0	15.87	6.0 - 28.0	212
„ polymorpho-nuclears	2.80	0.8 - 5.1	Not measured		
Basophil leucocytes ...	1.04	0.3 - 2.3	15.73	11.6 - 23.2	36
Proerythroblasts ...	0.96	0.5 - 1.4	15.60	11.6 - 19.9	74
Early normoblasts ...	3.30	1.5 - 4.9	13.40	9.1 - 19.0	135
Intermediate normoblasts	31.86	27.2 - 37.3	9.19	5.8 - 17.0	249
Late normoblasts ...	9.91	4.9 - 15.1	5.37	4.0 - 9.0	246
Plasma cells	0.35	0.0 - 1.0	12.44	9.1 - 16.6	30
Reticulum cells	1.12	0.8 - 2.0	16.78	11.6 - 23.2	48
Lymphocytes	1.73	0.6 - 3.1	Not measured		
Monocytes	0.26	0.0 - 0.7	Not measured		
Megakaryocytes			70.94	31.0-107.0	36
M/E ratio ...	1.103 : 1	0.77 : 1 - 1.68 : 1			
Mitotic forms	0.84	0.2 - 1.6			

* These figures include 'Stab' cells.

TABLE III

Differential Nematode count for 10 Cheviot ewes used for bone marrow biopsy.

Ewe's Number		Ostertagia Circumcincta	Trichostrongylus Axei	Trichostrongylus Colubriformis	Cooperia Curticei	Bunostomum Trigonocephalum	Strongyloides Papillosus	Chabertia Ovina	Larval Stages	Total worm count
68	...	0	0	0	0	2	0	0	0	2
54	...	50	0	0	0	32	0	2	250	334
56	...	50	750	0	250	24	0	8	0	1,082
63	...	50	300	50	0	15	0	0	50	465
67	...	0	0	0	50	41	0	0	50	141
51	...	0	0	0	0	61	50	3	50	164
57	...	0	0	0	0	0	50	0	350	400
58	...	0	500	0	350	5	0	0	450	1,305
52	...	0	0	0	50	9	0	1	0	60
65	...	0	0	0	50	12	0	0	600	662

A CASE OF TIBIAL HEMIMELIA IN CATTLE

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Investigation and Case History

In the spring of 1948 a defective calf of a beef breed was submitted for examination from a carefully-managed herd free from any defects till that year. This was the second case in the herd, the farmer not having worried unduly over the first, which had arrived a few days before. The accompanying photograph shows the animal, the outstanding features being the short twisted hind legs, the large abdominal hernia, and a small cleft palate. The animal was a male and had been born alive, but being unable to stand was killed. A few days later a third affected calf was born. Externally it looked normal, except for abdominal hernia, but it was unable to stand—always falling to the ground when its hind quarters were raised. It also was male. From the farmer's description of the first abnormal calf, it resembled these later two. The herd was a small one of 20 cows, all served the previous year by the same bull in his first season. The familiar incidence suggested a genetic cause, and the pedigrees were therefore examined.

Pedigrees

The following table shows the pedigrees of all the calves born in 1948:—

TABLE I

Maternal grandsire	Dams	Sire	1948 calves Normal	Abnormal
M.F.	14	M.A.	12	2
M.F. (ggs) ...	1	M.A.	0	1
Other (2) ...	5	M.A.	5	0

A grandsire of M.F. and a great-grandsire of M.A. were found to be the same animal.

Dissection of the Calves

The dissection of the posterior extremities of one of the calves was carried out by Dr. T. C. Carter, and the following is his description of the condition. The drawings were made by Mr. E. D. Roberts.

1. VISCERA

(i) There was a midventral, hemispherical hernia about 8 in. across in the region immediately anterior to the pelvic girdle. Its wall appeared to be devoid of muscular fibres, though the rectus abdominis muscles are normally fused together in the midventral line at this level. (Sisson and Grossman. 1949.) The penis traversed the ventral surface of the hernia.

(ii) The left testis was undescended; the right testis epididymis and associated ducts were not found. No other anomalies were seen in the rest of the urogenital system.

2. SKELETON

(i) *Pelvic girdle:*—

(a) There was no symphysis pelvis: the innominate bones were separated ventrally by a gap about 2 in. wide which was crossed by a thin ligament.

(b) The innominate bones were abnormally flat, so that the pelvic cavity was greatly reduced: the deep surfaces of the two bones were separated by only 1 in. in the region of the acetabula.

(ii) *Femur.*—This was markedly abnormal. The angle between neck and shaft was larger than usual: the medial condyle was reduced almost to absence: the lateral condyle was abnormally large.

(iii) (a) *Tibia.*—The tibia was absent, neither cartilaginous nor ligamentous elements were found in its place, but there was a small tuberosity on the medial side of the head of the fibula.

(b) *Fibula.*—The fibula was a bony element about 1½ in. long, ½ in. in diameter at its proximal and ¼ in. at its distal end. Its head was in contact with the lateral condyle of the femur, to which it was closely tied by a ligamentous sheath. There was no proper articulation. Its distal end was likewise closely tied to the proximal end of the talus.

(iv) *Tarsus.*—The most striking abnormality in the tarsus was in the shape of the talus, which was devoid of any trochlea for articulation with the

FIG. 1

(*Article by Young, page 23*)

leg-segment. The ligamentous connection between the talus and the fibula was such that the medial side of the distal end of the fibula was held in contact with the dorsal face of the proximal part of the talus: the foot was therefore rotated about its own long axis through a right-angle and the lateral surface of the foot faced the ground. In addition, the lateral parts of the tarsus appeared to be disproportionately longer than the medial parts, so that the tarsus was curved morphologically mediad: as a result, the long axis of the calcaneus was at an angle of about 40° to the long axis of the metatarsus. There were several strong ligaments running from the proximal part of the talus to the dorsum of the tarsus. No abnormal fusions were found between the bones of the tarsus.

(v) *Metatarsus.*—The large metatarsal bone was grossly abnormal except at its proximal end, where the anticular surfaces were offset, thus continuing the bowing of the tarsus. Nothing was found which could be homologised with the small metatarsal.

(vi) *Phalanges.*—The digits appeared to be normal.

3. Limb Musculature

(i) *Gluteal region.*—No muscular anomalies were found in this region.

(ii) *Thigh.*—The only anomalies found in the thigh muscles were:—

(a) Those muscles which normally insert on to the tibia (semitendinosus, semimembranosus, biceps femoris, rectus femoris, the vasti) inserted instead on to the thick anterior fascia covering the region of the femoral condyles.

(b) The medial thigh muscles (gracilis, pectineus and adductor femoris) could not be separated; they were apparently fused together.

(c) The anterior thigh muscles (rectus femoris and vasti) were small and their common tendon was not clearly distinguishable from the anterior fascia of the femoral condyles; no patella was found.

(iii) *Leg.*—There were very considerable changes in the leg musculature. The muscles found, and the muscles of normal calf with which they were considered to be homologous, were:—

(a) *Gastrocnemius.*—This muscle originated by two heads: one a fairly long origin on the lateral supracondylar crest of the femur, the other a long origin on the medial side of the distal third of the femoral shaft. The two short bellies were fused along their line of contact, and each belly gave rise to a wide tendon. The anterior part of the medial tendon inserted on the medial side of the tuberosity of the calcaneus; the posterior part passed superficially to the lateral side and inserted on to a ligament running from the talus to the tuberosity of the calcaneus. The posterior part of the lateral tendon also inserted on to this ligament; the anterior part of it crossed deeply mediad to insert on to the tuberosity of calcaneus immediately anterior to the tendon of the plantaris muscle.

(b) *Plantaris.*—This muscle had a short origin on the lateral side of the distal end of the femoral shaft, immediately medial to the origin of the lateral head of gastrocnemius. Its belly was short and very thick, and gave rise to a large tendon which first inserted on to the tuberosity of the calcaneus, then continued along the plantar surface of the foot as the superficial flexor tendon.

(c) *Soleus.*—This muscle was small but distinct. It originated on the posterior side of the head of the fibula and inserted on to the tuberosity of calcaneus with the tendon of the lateral head of gastrocnemius.

(d) *Popliteus.*—This muscle was small, lamellar and triangular. It arose from the deep fascia over the lateral condyle of the femur and inserted widely on to the fascia over the medial condyle, having crossed the posterior face of the condyles.

(e) *Tibialis posterior.*—This muscle originated by two heads. One was on the head of the fibula in common with the origin of soleus; the other was on the medial side of the medial femoral condyle. The lateral head ran deep across the posterior face of the femoral condyles, immediately distal to popliteus, and fused with the medial head on the medial side of the leg. The joint-tendon first gave off a slip which inserted on the sustentaculum tali; the main tendon then passed along the medial side of the tarsus, deep to the deep flexor tendon, and inserted on to the medial side of the deep face of the deep flexor tendon at mid-metatarsal level.

(f) *Flexor fibularis.*—This muscle originated partly by a tendon from the lateral supracondyloid crest of the femur, distal to the lateral origin of gastrocnemius, and partly from the head of the fibula. Its short, thick belly gave rise to a tendon which crossed to the medial side of the tarsus, reached the plantar aspect of the long metatarsal bone and became the deep flexor tendon.

(g) *Flexor tibialis.*—This was a small muscle which originated on the posterior side of the head of the fibula, immediately medial to the origin of soleus. Its short, thin belly went over into a tendon which fused above the level of the tarsus with that of flexor fibularis.

(h) *Tibialis anterior, peroneus tertius and extensor digitorum longus.*—These muscles were presumably represented by a superficial, lamellar muscle which originated from the anterior fascia over the femoral condyles and covered the anterior part of the leg-segment. The muscle was partly divided into a medial and a lateral portion, each of which gave rise to a wide tendon. Both tendons inserted on to the talus: the lateral tendon on to the anterior part near the distal end of the fibula, and the medial tendon on to the medial side.

(i) *Extensor digiti tertii.*—This was a fairly large anteromedial muscle with its origin immediately deep to the medial part of the last. It was divisible into three lobes, the lateral being the smallest and the other two about equal. Each gave rise to a tendon; the tendons fused at tarsal level and became the medial extensor tendon.

(j) *Peroneus longus.*—This muscle originated on the anterior fascia over the lateral femoral condyle, immediately lateral to the origin of peroneus tertius. Its belly was rather small and passed along the anterior side of the fibula. It went over into a tendon which passed through a synovial sheath on the lateral side of the talus, crossing the tendon of the lateral extensor, reached the lateral side of the tarsus, passed through a deep groove in the lateral and plantar aspects of the naviculocuboid bone, and finally inserted on to the medial-plantar region of the tarsus and metatarsus.

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(k) *Extensor digiti quarti.*—This was a large muscle originating by two tendons on the lateral side of the shaft of the femur, distal to the lateral origin of gastrocnemius. The anterior tendon gave rise to a large muscle-belly which lay immediately posterior to that of peroneus longus. It passed anterior to the distal end of the fibula, went over into a thick tendon at the level of the talus, followed the dorsum of the foot, and inserted as the lateral extensor. The smaller posterior head followed a similar course except that it went over into a tendon at fibular level; this tendon passed in a synovial sheath posterior to the distal end of the fibula and then fused with the tendon of the anterior head.

(iv) *Foot.*—Only minor changes were found in the foot muscles; these were :—

(a) A broad tendinous sheet, containing some muscular fibres, arose on the lateral side of the plantar aspect of the calcaneus and inserted widely on to the deep flexor tendon in the position appropriate to the quadratus plantæ muscle of those species which have such a muscle.

(b) The short digital extensor did not receive a tendon from the long extensor.

4. Nerves and Vessels

No detailed dissection was made of the nerves and vessels. Attention was paid to them only when, by their relationships, they threw light upon the identity of the leg muscles (e.g., the superficial peroneal nerve, the popliteal vessels).

The Comparative Aspects of the Condition

The condition is of particular interest since similar anatomical conditions occur in various vertebrates including mice (Carter, 1949) and in men (Dankmeijer, 1935). Carter found that the condition in mice was genetic, and that the gene responsible is not completely recessive since it may, when heterozygous, produce bone abnormalities at the distal extremities of the hind leg, causing polydactyly generally. When homozygous, the gene usually produces dystrophy of the bone in varying degrees, the dystrophy spreading from the distal extremity to the proximal. The condition may be either unilateral or bilateral, and may affect both males and females. In man, Dankmeijer found 57 cases of absence of the tibia recorded since 1861. Of these, 21 were bilateral. The defect was in 35 males and 22 females.

Pedigree Analysis of the Case of Tibial Hemimelia

The possibility of recessiveness

Examination of Table I reveals that out of the 20 dams, 14 had been sired by the bull M.F.

Two of the mothers of the luxate calves were sired by M.F., and the mother of the third was the granddaughter of M.F. If M.F. had been a carrier, one would expect half of his daughters to be carriers, i.e., about 7 of these 15 mothers. If all 15 daughters are served by another carrier bull, one would expect 1 in 4 of the calves of the carrier cows to be luxate, i.e., 1 in 8 of all

the calves. If we suppose that M.A. (which was a new bull being used for the first time in the herd) was a carrier, then the presence of 3 affected calves out of 15 potential carrier mothers is close enough to a 1 in 8 ratio to provide a reasonable explanation for the condition. (Chi-square = .8, d.f. = 1, P = .4.) The condition is, therefore, probably caused by a recessive gene.

Possibility of Detecting Carrier Animals

Since in the similar condition in mice and men carriers sometimes show bone abnormalities, and can therefore be detected, it was thought that a similar situation might exist in cattle. If this were found to be true, it would have been very convenient since carrier animals, especially bulls, could be detected and removed from affected herds. It was therefore decided to examine clinically the animals to try to find any abnormalities, especially bone abnormalities of the hind limbs. No defects were in fact found in the herd. X-ray examination of the hind limbs of several animals, which might have been carriers, revealed nothing. It was concluded that carriers probably exhibited no defects.

Summary

A new lethal abnormality in cattle called "tibial hemimelia" has been recorded, an anatomical description given, and pedigrees of the affected animals shown.

Acknowledgments

The writer is indebted to Dr. T. C. Carter for carrying out the dissection and for many helpful suggestions, to Dr. H. P. Donald for his interest in the condition, and to Dr. J. M. Rendel for submitting the case to him. Prof. Boddie carried out the X-ray examination.

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THE CONTROL OF FOWL PARALYSIS*

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INTRODUCTION

THE disease known to the poultryman as fowl paralysis has several manifestations, in some of which there is no paralysis at all. The characteristic feature common to all forms of disease is the accumulation of undifferentiated lymphocytes in the nerves, in the visceral organs, or in the iris. It is not surprising, therefore, that fowl paralysis should have many other names: lymphomatosis, neuro-lymphomatosis, the avian leucosis complex, iritis, and

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"big-liver disease." Some pathologists also include osteopetrosis, or marble bones, as one form of this complex, but flocks highly susceptible to all other forms of leucosis may never show a case of marble bones.

The evidence to date indicates that the disease is caused by a virus or, more likely, by several different viruses. Although many studies have been made of the ways in which these causative agents are spread and maintained, there is still much to be learned. In the present discussion of control measures, it is assumed that in populations where the disease is enzootic, the causative agents are ubiquitous, and inescapable except by the most rigid special precautions.

Control by Isolation

A. Complete isolation

The feasibility of reducing losses from fowl paralysis to an insignificant figure by strict isolation was demonstrated by Kennard and Chamberlin (1936) in the U.S.A., and by Johnston and Wilson (1937) in Scotland. Chicks taken from the incubators to isolated rearing ranges are mostly resistant to the disease when brought back to infected premises at about 5 months of age. At Cornell University, Dr, R. K. Cole and I have found that birds with a high degree of genetic susceptibility may still contract the disease when exposed at 160 days of age. However, these are the exceptions.

For those who can maintain an entirely separate establishment for rearing their birds, isolation provides the most effective control. To be effective, it must begin as soon as the chicks come out of the incubator. We have found that exposure for two weeks after hatching is enough to ensure a high death-rate later from leucosis (Hutt *et al.*, 1944). In fact we now get, in our strain bred for susceptibility, losses exceeding 50 per cent following an exposure that is severe for only 13 days after hatching.

Complete isolation entails not only a separate farm or location for rearing, but also separate equipment and attendants that have no contact with older birds. The effectiveness of this method of control has been established by those poultrymen who have been able to use it. Unfortunately, many of us are not able to maintain two separate establishments—one for laying birds and one for growing chickens. Some manage it by getting a farmer who has no poultry of his own to rear the birds to maturity.

B. Partial isolation

Poultrymen unable to provide complete isolation can still reduce their losses from fowl paralysis by brooding their chicks as far as possible from the old hens and by reducing traffic between these two groups to a minimum. It was a great surprise to find that our chicks brooded for the first two weeks 110 feet from the nearest laying pen got a less severe exposure to leucosis than their siblings brooded in the same year only 40 feet from old hens. This difference was maintained consistently during seven annual rearing seasons. It could not be ascribed to any difference in management other than in distance from the old hens. Although this difference in exposure lasted only 13 days, after which the chicks all went to the same rearing range, it was enough to make later

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deaths from leucosis in the birds brooded near the old hens two to three times as high as they were in the others.

Other evidence has since confirmed this indication that brooding chicks as far as possible from the old hens, even if the same equipment and attendants must be used for both, is about the best protection (short of complete isolation) that can be provided. The most critical period lies in the first few weeks after hatching.

Control by Breeding

The early evidence of Asmundson and Biely (1932) that families differ in susceptibility to fowl paralysis can be confirmed by almost any breeder who examines his records. Such genetic differences among families, when properly manipulated, can be effectively used to reduce losses from this disease. There are essentially two procedures available—mass selection and progeny testing.

A. *By mass selection*

With this system one uses nonpedigreed birds or ignores pedigrees, and breeds only from what our poultrymen call yearlings or from hens still older. Actually, yearlings are about two years old when used. If the stock has been exposed to the paralysis complex, and the most susceptible birds thus eliminated by natural selection, the survivors should transmit some of their own genetic resistance to their offspring. That they do is shown by Kennard (1933),and by Gildow *et al.* (1940), who compared yearlings and pullets with respect to losses from paralysis in their offspring. Their results were as follows:

TABLE I

	Paralysis (%) in offspring of:	
	Hens	*Pullets*
Kennard, first year	12.5	20
Kennard, second year	16.0	30
Gildow *et al.* Series I	27.4	34.7
Gildow *et al.* Series II	17.0	24.6

These data suggest that, with mass selection of this sort, losses from paralysis should be more than 7 per cent below those that would be experienced when hatching only from pullets. If the hens used for breeding have been properly culled, they should be better than the pullets in other respects, as well as in demonstrated viability, hence this method of reducing losses has much to be commended.

B. *By progeny testing*

As with other multifactorial characters, when breeding for resistance to leucosis one goes farther and faster with the progeny test than with mass selection. Incidentally, the progeny test is more exciting.

For the past 15 years, Dr. Cole and I have been breeding two strains of White Leghorns resistant to this disease, and one strain that is highly susceptible. The procedure during that time has been (1) to pedigree all chicks, (2) to ensure a natural exposure to leucosis, (3) to maintain as nearly as possible

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a uniform environment for all birds, (4) to determine the cause for every death after the age of six weeks, and (5) to breed from sires and dams proven to produce offspring that are comparatively resistant to the disease and otherwise desirable. The testing period is from 43 to 500 days. Details of the experiment and some of the results have been given in previous reports (Hutt and Cole, 1947b, 1948).

In the two resistant lines, deaths from leucosis among females hatched from proven-sire matings are now usually less than 10 per cent and sometimes less than 5 per cent. These are averages for the strains; some individual sires may lose no more than 3 per cent. This is not too bad for a test period of 458 days, and for birds that are never culled, even when housed. It is particularly good for birds exposed so severely that in the susceptible line deaths from leucosis are well over 50 per cent in the same period. Since birds of all three strains are mixed together right from hatching, it is evident that they must all be getting an adequate exposure.

In the population hatched in 1949, which will finish its test about September 15, the records up to July 1 for 28 previously untested sires in the two resistant lines were as given below. Since no cockerels of the Susceptible line were tested in 1949, the proven-sire matings of that strain are used for comparison to give some idea of the severity of exposure.

TABLE II

	Sires Number	Daughter at 43 days Number	Deaths from leucosis Per cent
K—Resistant	13	813	4.2
C—Resistant	15	650	6.9
Susceptible	4	343	63.8

The general reduction of deaths from neoplasms over a period of years is shown in Table 1. Actually the improvement effected by selection was much greater than the figures in that table show. Since 1942 the exposure has been more severe than in the first seven years of the experiment, and some obscure forms of leucosis are now recognised at autopsy that were missed in earlier years. The reduction of mortality from all causes as these strains increased in resistance has been remarkable.

Resistance, Eggs, and Economics

Strains of mice and rats resistant to disease have been bred in more than one laboratory, but the problem is more complicated with domestic fowls. The latter have to be satisfactory not only from the standpoint of resistance to disease, but also in ability to lay, in size of egg, in body size, and in ability to reproduce. None of these objectives is incompatible with resistance to leucosis, but it is much more difficult to improve five characters than one. To do it, one must test many cockerels annually in order to find the few that transmit superiority in all the things that are valued.

For the poultrymen with many breeding pens it is easy to test many cockerels each year. Having only ten pens available for such tests, we have used since

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1943 a system of multiple shifts by which those ten pens are made to test annually 30 cockerels and even the 40 that we tried in four successive shifts this year. Time permits no detailed account of this system here, but it is fair to say that if we had put it into effect in 1936, we should probably have made in that way more progress in five years than we actually made in ten.

Along with resistance to disease, egg size and size of bird were soon raised in our Leghorns to the point where little further selection was necessary, but laying ability, although it had steadily improved, still needs consideration.

Practicability of Genetic Control

The feasibility of breeding birds resistant to leucosis and capable of high egg production has also been demonstrated at the Alabama Experiment Station. However, the breeder not financed by governmental funds may well question the practicability of his developing such resistant stock. The answer to that question is that some of the best breeders are already doing it, and are finding that it pays. This is particularly so for the hatcheryman whose chicks are despatched to many a farm where they are exposed to leucosis. One of these men when asking for advice on how best to expose some of his pedigreed stock wrote:

> "We have not had much paralysis on our farm. We also have many customers who say that they house more pullets than they pay for. On the other hand, we have some customers who just cannot grow our stock because they have so much paralysis. We feel we have a top-notch breeding farm and we would like to tackle this paralysis in a realistic way."

Certainly it is hardly practicable for any breeder to maintain a highly susceptible strain, as we do at Cornell. But that is not essential. Neither is it practicable to expose all the chicks each year. That is not necessary either. It should suffice to expose only a sample from the pedigreed matings—perhaps three hatches out of ten—just enough to show up the best and worst families. The necessary exposure can usually be ensured by brooding the chicks close to old hens, using the same attendant for both. Sometimes they get it even when held in battery brooders in a room where there are some old hens in other batteries.

Apart from these samples that are exposed, the breeder should rear the rest of his stock in isolation, or in part isolation, just as the commercial poultryman should do. When a fair degree of resistance has been established by some years of selection, it may then be feasible to expose a large proportion of the flock without incurring serious losses.

Some breeders attempting to develop stock resistant to leucosis have, in a few years, reduced the disease to an insignificant figure, only to find that their supposedly resistant stock suddenly becomes susceptible again. The trouble in such cases is that the flock has "run out of exposure," and hence appears highly resistant. Sires whose daughters are unexposed may appear to be transmitting high viability, but exposed daughters of these same sires may reveal an entirely different story. The safest plan is to ensure some exposure annually. Admittedly the best ways of doing this have yet to be discovered, but the surest way seems to be to have some old hens close to the brooders.

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Utilisation of Resistant Stock

Indications are that the best practical control of fowl paralysis is secured by raising genetically resistant stock in the best possible environment, i.e. in isolation, whether complete or partial (Figure 2). The breeder or hatcheryman who distributes chicks from such stock should therefore not leave all the battle to their genes, but should make every effort to ensure that the customer does his part by brooding these chicks far away from older birds.

There are some indications that cockerels of a resistant strain, when used on unselected stock, will transmit a high degree of resistance. If further evidence confirms these first trials, it is clear that the maximum utilisation of the good genes accumulated in resistant strains will be obtained by using cockerels of such strains to head supply flocks for the hatcheries.

Tests for Resistance of Different Strains

After it became evident that flocks which have experienced leucosis for several years (and hence have undergone some natural selection) are safer sources of chicks than flocks which have never been exposed, it was not long before breeders began making claims that they had strains resistant to this disease. Just as the first laying tests were set up to reveal which stocks had superior ability to lay eggs, the first test is now under way in New York State to compare the viability of different strains—particularly their resistance to leucosis. It is a test not solely of viability, but of that happy combination of abilities to survive and to lay well that is necessary for maximum profit.

The entries in this test consist of 52 unpedigreed pullet chicks which have to be selected at random from many hundreds by some approved, disinterested agent. It is thus a "fair-sample" test. The unique thing about it is that on receipt of the entries at Cornell University the chicks are all exposed to leucosis for three weeks before going to the rearing range. Their productivity and viability will be determined to 500 days of age. Names of the outstanding strains will be announced, but, by the use of code numbers, breeders of the more susceptible stocks will be protected from public exposure. The point of interest to us is that there were over 70 breeders who applied for this opportunity to test the ability of their birds to withstand leucosis and to lay. Unfortunately the space available permitted acceptance of no more than 33 entries.

The Will-o'-the-Wisp of Egg Transmission

For some years it has been claimed by Waters (Waters and Prickett, 1944; Waters, 1945, 1947) that the agents causing leucosis are transmitted through the egg to the chick, thus establishing a focus of infection for the new generation. This claim has now been extended (Waters and Bywaters, 1949) to include a theory that chicks are infected in the incubator by dissemination there of the causative virus. These theories have been clutched by despairing poultrymen as a drowning man grasps at a straw. They have been enlarged and circulated by the world's poultry press to such an extent that many a poultryman now expects that his troubles will soon be ended by the discovery of some simple test whereby reactors carrying the virus may be detected and eliminated. I am not one of these cheerful optimists.

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By reciprocal crosses between resistant and susceptible strains it was shown that, whether the virus goes through the egg or not, any such transmission is of no consequence whatever in comparison with the genes that the chick gets through that same egg from his sire and from his dam (Hutt and Cole, 1947a). It was also shown that even birds that died of leucosis, which should have been able to infect their offspring through the egg if any birds can, did not produce in the months preceding their deaths chicks any more susceptible than those of hens that did not die of leucosis (Cole, 1949).

More recently we have used our Susceptible strain of White Leghorns to get a little more light on this question (Cole and Hutt, 1950). Chicks of this strain that were exposed to infection in 1948 and 1949 suffered mortality from leucosis of 54 per cent in one year, and over 64 per cent in the other, before they were 500 days old. At the same time, two hatches were raised each year in compartively good isolation. Among 280 pullets thus isolated, only a single case of leucosis developed while they were isolated. After they were returned to infected premises at 160 days of age, mortality from leucosis to 500 days was only 9.4 per cent in one year, and even less in the next. If the causative agents are transmitted through the egg, these birds should have shown some effects if any would. The evidence indicates that those which did die of leucosis got their infection—not through the egg—but from the exposed population, after the isolated birds were brought back to winter quarters.

In this connection, the recent findings of Oakberg (1950) have a special interest. They support the previous evidence of Pappenheimer *et al.* (1926) that lymphomatosis exists in some form in most chickens that have been exposed, if not in all. It seems probable, therefore, that if any test for carriers be devised, it would disqualify practically every bird in the breeding pen. This evidence of general infection is consistent with the fact that highly resistant birds that have withstood severe exposure and produced highly resistant offspring, will sometimes succomb to leucosis when old age has broken down their natural defence. The hope of eradicating the disease by eliminating carriers is a will-o'-the-wisp.

Consoling Philosophy

There is nothing new about having to live with a disease instead of eradicating it. Most of us are so resistant to chicken pox, measles and whooping cough that we accept them as normal occurrences. Unexposed primitive populations in which there has been no natural selection, do not fare so well with these diseases. In North America about 95 per cent of the adults show by blood tests that they have been exposed to one or more of the viruses causing infantile paralysis. We do not eradicate these reactors. It is only the few, who are genetically highly susceptible, that have trouble. We do our best to save them, and thus to frustrate natural selection. In contrast, so far as fowl paralysis is concerned, natural selection can be utilised to the full. It can be supplemented by careful breeding to eliminate susceptible families, to accumulate genes for resistance and ultimately to produce stocks that can withstand ordinary exposure to the disease.

XUM

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PARASITIC CYST IN THE ORBIT

Successful Surgical Removal with Preservation of the Eye

By C. R. S. JACKSON, B.M.(Oxon.), D.O.M.S.(Lond.).

Nuffield Laboratory of Ophthalmology, Oxford

THIS case is reported as an example of the successful surgical removal of a parasitic cyst from the orbit of a rabbit. Though no particular value was attached to the animal in this case, it is considered that the relative ease of approach might usefully be pointed out to others faced with a similar problem in a more valuable animal.

Apart from the cosmetic effect of unilateral exophthalmos an eye which is abnormally prominent is exposed to greater risk of abrasion of the cornea and to the sequelæ resulting therefrom, particularly corneal ulceration and perforation. Further, if the eye is not adequately protected by the lids in sleep there is considerable risk of corneal desiccation and consequent infection.

XUM

Case Report

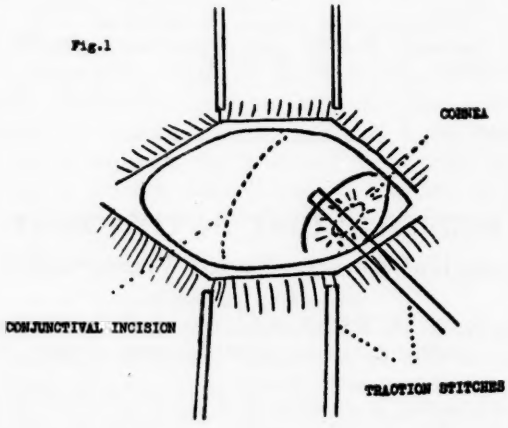
An adult Dutch rabbit was presented as a case of unilateral exophthalmos, with a request for an opinion as to the ætiology of the condition. It was a laboratory animal and there was no question of it having been injured.

The animal had gross unilateral exophthalmos affecting the right side, the eye being pushed bodily upwards and backwards, in addition to its lateral displacement. It was difficult to measure the degree of protrusion but it was estimated at between 7 and 10 mm. A soft swelling could be felt in the lower anterior part of the orbit and the problem was obviously one of an orbital tumour. At this time the lids closed freely over the globe but the swelling had been said to have increased slowly during the previous few months and it was felt that the correct line was to explore the orbit in an attempt to remove the tumour and to reduce the exophthalmos.

Operation

Nembutal anæsthesia (1 cc. per 5 lb. body weight, intravenously). Surface anæsthesia with cocaine 4 per cent.

Retraction of the lids was maintained with sutures held in pressure forceps. The globe was rotated away from the tumour by a suture placed close to the cornea. The conjunctiva was incised along the line shown in Fig. 1, using scissors.



A thin-walled cystic swelling was at once exposed. It was wrapped round the globe and the muscles and appeared freely separable from them. With very little bleeding the cyst was dissected back towards the apex of the orbit, but the wall was torn at this point and about 7 c.c. of clear straw-coloured fluid escaped, together with a number of white seed-like bodies measuring about 0.5 x 2 mm., the significance of which was not then appreciated, but which were preserved.

PLATE I

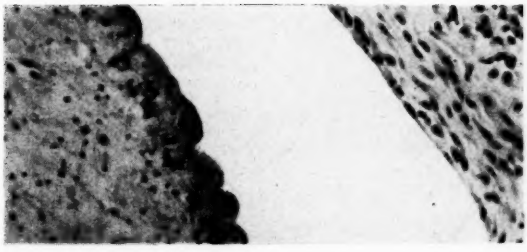


FIG. 2.

FIG. 3.

(*Article by C. R. S. Jackson, page 35*)

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PLATE II

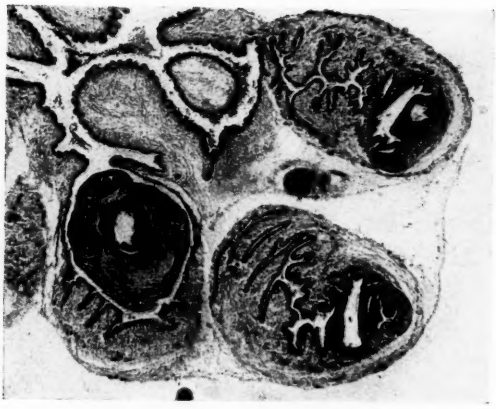

FIG. 4.

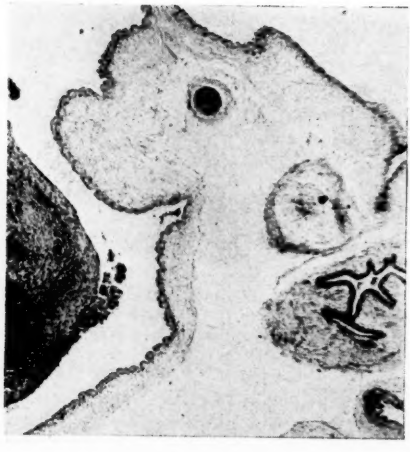

FIG. 5.

(Article by C. R. S. Jackson, page 35)

It was apparently possible to remove almost the whole of the wall of the cyst. The conjunctiva was repaired with thin silk and the lids were sewn together with a single mattress stitch to give protection in the post-operative period. This stitch was removed after three days. There was then no proptosis and the eye was moving normally.

Histology

Sections were cut after the cyst wall and contents had been embedded in paraffin.

The first impression was that this was some sort of foreign-body reaction on the part of the host. There was a mass of granulation tissue surrounding the cyst wall, which had an almost stratified appearance (Fig. 2). The granulation tissue was predominantly eosinophilic and it was this that raised the question of a parasite in my mind. Further search of the sections removed all doubt, the organism itself being found (Fig. 3). The white fragments escaping from the cyst when it was opened were scolices, of which there were many (Figs. 4 and 5).

Professor J. J. C. Buckley was kind enough to examine the sections and identified the parasite as *Coenurus serialis*, the larval stage of *Cœnia serialis*, an intestinal tapeworm of the dog.

Post-mortem

The eye having been normal for several weeks it was decided to sacrifice the animal and to search for further cysts and also to explore the orbit on the affected side for any evidence of residual trouble.

There was no evidence of disease in the orbit, apart from some slight fibrosis.

General examination revealed one further cyst, in the right pleural cavity. It was larger than that in the orbit and had compressed the lower lobe of the lung. The cyst was attached to the mediastinum by a thin vascular pedicle. There were no signs of inflammation.

Discussion

The striking feature about these cysts was the ease with which they could be separated from the surrounding tissues. Not being very vascular, bleeding from the wall was slight and easily checked.

Reviewing the case I wonder if it would be justifiable in another instance to evacuate such a cyst through an incision in its anterior wall. It could then be cleared out thoroughly by swabbing and allowed to fibrose. Knowing that the contents of certain parasitic cysts are very irritant to the tissues total removal of the cyst and contents is probably the treament of choice.

Summary

1. The successful surgical removal of a *T. serialis* cyst from the orbit of a rabbit is reported.

2. There are no serious technical difficulties in the operation, which allows the eye to be preserved.

I am grateful to Professor Buckley for kindly identifying the parasite for me.

REVIEWS

THE EFFECTS OF TEMPERATURE, HUMIDITY, AIR MOVEMENT AND SOLAR RADIATION ON THE BEHAVIOUR AND PHYSIOLOGY OF CATTLE AND OTHER FARM ANIMALS, by J. D. Findlay. Published by The Hannah Dairy Research Inst., 1950.

THIS is a most welcome review of a subject, or rather a whole group of subjects, of great physiological interest and of economic importance. Dr. Findlay has done well a task which urgently needed doing.

Within rather less than 200 pages a good survey of existing knowledge has been provided, while the last chapter contains the author's forecast of future developments in this field of research. It is impossible to summarise what is already a concise summary and it remains, therefore, merely to give some indication of the chapter headings under which the subject has been treated.

Dr. Findlay begins by discussing heat production in warm blooded animals and the various ways in which such heat may be dissipated, following which the influence of climatic environment upon grazing habits is dealt with. In succeeding chapters the effects of tropical environment upon such phenomena as the body temperature, respiratory function, heart rate, blood and milk of cattle are treated. These chapters on cattle conclude with an account of the function of the skin in heat dissipation and absorption. In one chapter the influence of tropical environments on sheep, pigs and poultry is disposed of—ample witness to a neglected field of animal research. Very nearly one half of the review is then occupied by discussions of the methods of measurement of the physiological phenomena mentioned above. The penultimate chapter deals with the planning and construction of a psychrometric room in which the responses of livestock to various artificial environments may be studied.

About 70 figures and plates are provided in the review, with some 20 tables of data. Each chapter has its own bibliography.

This is a review which should be read by all who are interested in livestock production. In attempting to raise animals in an unfavourable environment, one may try either to produce breeds which are suited to such conditions or to modify the environment. Although the work of recent years may have been directed mainly in connection with the former, the second method goes back to the time when Man first found shelter for his beasts. It is one of the merits of this review that Dr. Findlay has not forgotten the second possibility.

J.T.A.

A WORLD OF HORSES, by James Reynolds. Hutchinsons Library of Sports and Pastimes. Price, 20s.

JAMES REYNOLDS is a gifted painter and sketcher of horses and he is able to depict them so that they really "live on the canvas," and satisfy the ego of the men who know horses. Art may be his profession but there can be no doubt that from his boyhood days in Ireland horses have been the abiding theme of his life and caused him to journey about the world not only in search of copy but to see and ride horses and to talk horses with those of fellow feeling.

The result is a book written in a racy conversational style, which will delight the reader. He deals with the horse in antiquity, and leads us along to those great animals the Darley Arabian, the Godolphin Arabian, and the Byerly Turk and their mares, the foundation of the modern thoroughbred. There is information on breeds, breeding, racing, hunting, showing and riders. Throughout the book there are personal and historical anecdotes, many with a rich Irish flavour. The author's early days in that delightful sporting country must have made an indelible impression, for it colours all his words.

The illustrations are excellent and especially those by the author, for even those horses which prance about the covers of the book have such a lively snap in their action and switch to their tails that it would not surprise the reviewer if they gambolled off the page.

Horsemen and artists will enjoy this book.

DEPARTMENT OF AGRICULTURE, CANADA. Report of the Veterinary Director General. Year ended March 31, 1950.

THE report will be of most interest to veterinary surgeons concerned with public health work and meat inspection.

It is very gratifying to read that Canada is free of most of the contagious and destructive diseases of animals. Foot and mouth disease has not made its appearance for some years, and swine fever has not been reported since the latter part of 1946, whereas in Great Britain we read only too often about outbreaks of both of these diseases.

The country has been free of rabies since the early part of 1946, which speaks well for the Canadian control measures, when one remembers that rabies occurs not infrequently in the United States of America.

The Divisional Veterinary surgeons have been very active in their efforts too eradicate bovine tuberculosis. More than two and a half million cattle were tested with tuberculin.

For the further control of bovine brucellosis a uniform policy of country-wide application has been decided upon. This programme will be known as the " Federal-Provincial Brucellosis Control Program."

During the year ended March 31, 1950, Canada experienced six minor outbreaks of Newcastle disease. The outbreaks were quickly brought under control, also, the Canadian authorities are alive to the various routes by which this very destructive disease can gain entry to their country.

It is good to note that the importation, manufacture, sale, and the care of all veterinary biologics is under the control of the Veterinary Director General.

Semen can be imported for the purpose of improving stock, though artificial insemination, but only after application to the Veterinary Director General for a permit. A certificate signed by a veterinary surgeon of the national government of the country of origin is also required.

There are many pages of statistical matter, chiefly concerned with the eradication and control of bovine tuberculosis.

NUTRITION OF THE DOG, by Clive M. McCay, Professor of Nutrition, Department of Animal Husbandry, Cornell University. 2nd Edition, 1949. Comstock Publishing Co., Inc., Ithaca, New York. Price 27s. 6d.

SCIENTISTS have disclosed much fundamental information on which the modern knowledge of nutrition, in particular that of man, is based. Much of this knowledge comes as a result of experimental work performed on animals and the dog has been used to a great extent in this work. Consequently there is much information on the nutrition of the dog on record, but it is not generally available to those who work outside the ranks of the research teams or who have not a ready access to scientific libraries. There was a great opportunity therefore for someone, who was himself a research worker and yet understood the everyday problems of those who had the care of dogs, to sift the already voluminous mass of information scattered throughout the scientific press and extract therefrom that which could be understood even by a layman and put into everyday practice.

Professor McCay did this in 1943 when the first edition of his book was published. That edition received a great welcome. It also showed us how little we really knew of the science of nutrition as applied to the dog, how the dog keeper's knowledge was based upon pure empirical methods of trial and error, and further how selfish the research workers had been, for they had taken freely from the dog and yet had neglected to give in return so that the dog world at large could profit by the sacrifice of their canine fellows in the laboratories.

Professor McCay rectified this omission in 1943. Since that time we have had a textbook to which we could refer almost any canine nutritional problem. In this, his second revised edition, the scope of the book has been extended and much new information included.

Starting with an interesting account of the historical association between men and their dogs, in subsequent chapters the author reviews carbohydrates, fats and proteins, the mineral requirements of dogs, and the vitamin requirements of the diet. He makes these matters extremely interesting for throughout the text he refers to the experimental work by means of which the information was acquired.

Chapter IX deals with modern dog feeds, giving examples of the specifications of certain dry meals including their vitamin values. He gives examples of home mixed meals and how we can maintain dogs upon dry feeds. It is appropriate also that canned foods, so popular to-day, are discussed at length.

Chapter X is devoted to the ingredients of dog feeds, and the charts illustrating the feed preferences of several breeds is intriguing, for although one realises that individual or families may vary in this regard one does not expect such preference should extend to a whole breed. It is good to note that " Palatability " is emphasised, for during the last ten years even humans have suffered in this regard, for the non-imaginative food chemists who have been responsible for our food seem to be oblivious to the fact that " a little of what you fancy " will do you more good than a bucket full of proteins, fats and carbohydrates. In

Chapter XII he gives us information on methods of testing dog feeds, and again I am pleased to see that he does not forget palatability.

The Chapters XIV and XV on practical feeding and management and on kennels and equipment will be read with interest and profit by all kennel owners, especially those sections which deal with feeding.

Professor R. H. Udall is responsible for Chapter XVI, parasites and their control.

The final Chapter XVII takes the form of a catechism. No doubt this will be useful to veterinary students for I am sure that if a student could "read and digest" these questions and answers then he would face an examiner with the utmost confidence.

Professor McCay's book will appeal to a very wide field of readers from layman to scientist, and they will all find within its covers, knowledge which will help them in their particular spheres. The extensive series of references which are interposed throughout the work are extremely valuable and cover a very wide field in nutrition.

The illustrations are quite good, but I wish there were more of them for often a good picture, especially in this type of work, tells more than many words. It would be nice to see the portraits of some of the great researchers who have made their mark in nutrition.

LEHRBUCH DER INNEREN KRANKHEITEN DER HAUSTIERE EINSCHLIESSLICH DER HAUTKRANKHEITEN SOWIE DER KLINISCHEN SEUCHENLEHRE, "Textbook of Internal Diseases of Domestic Animals, including Skin Diseases and Clinical features of Infectious Diseases," by Prof. D. Wirth and Prof. K. Diernhofer. 2nd Edition. Stuttgart, 1950. Ferdinand Enke Verlag. Price 89 Marks.

A LARGE number of veterinary textbooks have been published since 1945 in Germany and Austria, many of them being new editions of books which were well known before the war. Many such new editions were long overdue but quite often it has been evident that the authors have been unable to bring their material up to date because of inability to consult the world literature of the past ten years.

The present book is a second edition of one which was first published in 1943 and although it is clearly intended to be mainly for the use of Austrian and German veterinary students it does not suffer markedly from any failure to take note of recent advances in veterinary medicine and thus may be of considerable interest to a wider public which is able to read German. The inclusion of such diseases as "hard pad," the use of sulphonamides, penicillin and antrycide and numerous references to other recent advances establishes the book as being well up to date. Much of the text has been rewritten and new illustrations have been added. The book itself is printed in large type on good paper and is well bound. It remains a textbook, rather than a handbook and does include references to published work.

There are short chapters at the end of the book dealing with diseases of fur animals, game, bees (Prof. Borchert of Berlin) and fish (Prof. Fiebiger of Vienna).

XUM

The aim of the book as expressed in the preface of the first edition, is to provide the student with an introduction to the science of veterinary medicine which will enable him to establish a firm foundation on which he can build his postgraduate experience in veterinary practice. A compromise between minute detail and restriction to a bare skeleton of knowledge is the aim. The book seems to provide a sound basis for the student's reading which, supplemented by his clinical teaching, should provide a satisfactory training in veterinary medicine.

The contents are grouped from the point of view of clinical and practical requirements, rather than on an ætiological basis. Thus, diseases which affect exclusively or mainly one organ or group of organs are grouped together: this arrangement applies equally to infectious and to non-infectious diseases. Efforts have been made to explain the nature of disease processes and how they produce the outward manifestations of disease. Difficulties and gaps in knowledge are not omitted, for the student must not be presented with a superficial picture of disease in which all problems are over-simplified. Laboratory aids to diagnosis receive due consideration.

In dealing with treatment the authors avoid giving details of every conceivable drug or other agent which may have been used and restrict their consideration to general methods of approach. Few proprietary therapeutic agents are mentioned. In general, the simplest, best established and most satisfactory methods of treatment are selected.

All good textbooks reflect the personal experience of the authors and this book contains much experience and observation which its authors have acquired over many years in the Veterinary High School in Vienna.

The book is divided into the following sections: Digestive organs (234 pages), urinary (35), peritoneum (7), respiratory (84), pleura (7), diaphragm (1), circulatory (36), blood (35), spleen (1), locomotor (18), metabolism (53), nervous (85), endocrines (10), unsoundness (9), skin (125), allergic conditions (3), special infectious diseases (351), fur animals (3), game (3), bees (11), and fish (13). There are many cross references throughout the text. The distribution of the subject matter is such as to make for a well-balanced book with adequate attention to important diseases and at least brief reference to almost all diseases which the practitioner is likely to encounter.

Since the book is essentially intended for use in Germany and Austria it naturally presents a picture of diseases as they occur in these countries and deals less fully with conditions peculiar to other lands, such as the tropics.

There is an average of one illustration for every four pages of text and most of the figures are small but clear. There is one coloured plate—it illustrates hyperæmia and nodular lesions of the penis and vagina of the ox in "vesicular exanthema" (Bläschenausschlag). The authors state that this acute exanthematous condition is transmitted by the bull and is caused by a filterable virus but they also mention recent work on *Vibrio fœtus* in Holland and give the impression that they are doubtful whether "vesicular exanthema" is a cause of enzootic sterility.

To some extent the authors have attempted to use the accepted nomenclature for bacteria, which makes it easier for readers outside Germany and Austria to realise what organism is concerned. With *Clostridia,* however, confusion still persists and British readers of this or most other German veterinary texts will often be quite unable to discover what organisms are concerned in the various clostridial infections of sheep and cattle. This book does not mention *Clostridium welchii.* Blackquarter in cattle is ascribed to *Clostridium feseri* and the same organism is quoted for the sheep. " German braxy " seems to be " black disease " because the authors state that it is caused by *Bacillus gigas* and is associated with liver necrosis and invasion by liver flukes. It seems doubtful whether the form of braxy which occurs in Britain has been recognised in Germany. Lamb dysentery and enterotoxæmia do not appear to be mentioned. Unless sheep diseases caused by clostridia differ greatly from those occurring in other countries there is clearly a need for clarification of the bacteriological agents concerned and perusal of a recent German book on sheep diseases confirms the view that this subject urgently requires investigation. The whole subject of sheep diseases is inadequately dealt with in this book, which is somewhat strange in a text which covers a field so wide as to include diseases of bees and fish. If other diseases caused by *Clostridia* do occur in Germany and Austria it is important that they should be recognised and that the methods of protective inoculation used in other countries should be introduced. This cannot be done unless the precise ætiology is established.

For the veterinary student who is taught German this book will undoubtedly be of great value. As a work of reference for a wider public the book is of interest although the fact that it is textbook and without references to the literature will diminish its value for this purpose. Bacteriological statements form the weakest section of the text—the classification of *Clostridia,* reference to *Salmonella* as " toxin-producers " (p. 69), and such statements as " Fowl typhoid bacteria have been shown to produce gastroenteritis in man after consumption of infected eggs " inserted at the end of the section dealing with bacillary white diarrhœa and fowl typhoid (p. 82), and yet not in the section dealing with *Salmonellosis* in ducks require modification in future editions. With these reservations, the authors are to be congratulated on producing a useful textbook for veterinary students.

FIFTY YEARS WITH DOGS, by Colonel E. H. Richardson and Mrs. Richardson. Hutchinson & Co. Price, 20s.

THE joint authors are so well known in this and many other countries as the pioneers in the art of dog training that their names would indeed be a sufficient recommendation for this book. Ever since the time when they were first domesticated, dogs have been trained to all manner of uses but it was Col. Richardson who first trained dogs specifically for guard duties and presented what might be called a logical curriculum for that training which has stood us in good stead for many years, and particularly in the first and second world wars and for police duty.

A good trainer of dogs must be something of an animal psychologist and be an expert in that intriguing subject " Animal Behaviour." When one reads the book there can be no doubt that the authors were gifted in this way and it is good that they have been able to place their methods on record so that the art of dog training can be changed from empiricism to a basically sound science. To many the most interesting chapters will be those dealing with the training of army and police dogs, but the scientist will read with great interest the chapters on " The Soul of a Dog," and " Metaphysics of Training." These two chapters are of especial interest to those who make a study of the human brain. It may be that a better understanding of animal behaviour or reaction may be the first door to be opened in order to gain a fuller understanding of the human mind. We can recommend this book to all who love dogs, and are interested in their training, and we thank these pioneers for putting their thoughts and methods on record.

NEWS

TETANUS ANTITOXIN; New International Unit

BURROUGHS WELLCOME & Co. announce that from January 15, 1951, all strengths and packings of " Wellcome " brand Concentrated Tetanus Antitoxin (Veterinary) will be labelled in terms of the International Unit (1950).

The 1950 International Unit, which has been adopted by all member nations of the World Health Assembly, is twice as large as the existing International Unit. The same material measured by it contains half the number of units it contains when measured by the Standard of the previous Unit, now known as the International Unit (1928).

Packings are now labelled as follows:—

1,000 International Units (1950) (= 2,000 I.U. [1928]).
1,500 International Units (1950) (= 3,000 I.U. [1928]).
5,000 International Units (1950) (= 10,000 I.U. [1928]).
25,000 International Units (1950) (= 50,000 I.U. [1928]).

The therapeutic value of any quantity of " Wellcome " Concentrated Tetanus Antitoxin is not affected by this change in labelling.

Publishers' Notices

THE BRITISH VETERINARY JOURNAL, with which is incorporated THE VETERINARY JOURNAL, is published monthly, and copy for advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 20th of the preceding month, if proof is required. Tel.: Temple Bar 3386.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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